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Technical Report ARWEC-TR-01011

OPTIMIZATION OF GASKET MATERIALS FOR METAL PACKING CONTAINERS FOR MORTAR AMMUNITION

Yash Sinha

January 2002

US ARMY
TANK AUTOMOTIVE AND
ARMAMENTS COMMAND
ARMAMENT RDE CENTER

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

Warheads, Energetics & Combat-support Armament Center

Picatinny Arsenal, New Jersey

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-01-0188*

1. REPORT DATE *(DD-MM-YYYY)*
January 2002

2. REPORT TYPE

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE

OPTIMIZATION OF GASKET MATERIALS FOR METAL PACKING CONTINERS FOR MORTAR AMMUNITION

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

6. AUTHORS

Yash Sinha

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

ARDEC, WECAC
Packaging and Engineering Support Division (AMSTA-AR-WEP)
Picatinny Arsenal, NJ 07806-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

ARDEC, WECAC
Information Research Center (AMSTA-AR-WEL-T)
Picatinny Arsenal, NJ 07806-5000

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Technical Report ARWEC-TR-01011

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The U.S. Army Armament Research, Development and Engineering Center's Packaging and Engineering Support Division, Picatinny Arsenal, New Jersey initiated a Product Improvement Program (PIP) to solve the deterioration problem in the gasket of mortar's metal containers. This PIP was funded by PM-Mortars. The PIP addressed the gasket material properties including: durometer, hardness, compression set, impact resistance, and other physical properties. The goal was a find a gasket material, which would improve the seal, long-term storage, and transportation capability of both 120-mm and 81-mm metal containers. The environmental and material tests showed that neoprene is the best gasket material for mortar metal ammunition containers. Styrene butadinene rubber and natural rubber (60) were discontinued from the environmental testing because of their poor performance in material tests (heat, oil, and grease). The ethylene propylene diene material did not perform well in the drop and leak tests.

The environmental and material testing results both pointed out that the neoprene material was the best material for the application. The current contractor (B-Way Corporation) performed the tests in October 2001 and agreed that the neoprene gasket performs as well or even better than the current natural rubber. The Packaging and Engineering Support Division recommends using neoprene across the board for 60-mm, 81-mm, and 120-mm metal shipping containers. Engineering Change Proposals (ECPs) are being submitted to incorporate the improvements.

15. SUBJECT TERMS

Styrene butadinene (SBR) Ethylene propylene diene (EPDM) Natural rubber (60) Natural rubber (40)
120-mm metal container 81-mm metal container Gasket materials

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19B. TELEPHONE NUMBER *(Include area code)*
Unclassified	Unclassified	Unclassified	SAR	38	

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

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BACKGROUND

The U.S Army Armament Research, Development and Engineering Center's (ARDEC) Packaging and Support Division, Picatinny Arsenal, New Jersey initiated a Product Improvement Program (PIP) to solve the deterioration problem in the gasket of the metal containers for mortar ammunition. This PIP was funded by PM-Mortars. The PIP addressed gasket material properties including: durometer, hardness, compression set, impact resistance, and other physical properties (app. A). The goal was to find a gasket material that would improve the seal, long-term storage, and transportation capability of both the PA154 (120-mm) and PA156/PA157 (81-mm) metal containers. Four materials that were recommended by ARDEC's Warhead, Energetics and Combat-support Armaments Center (WECAC) Material Laboratory were ethylene propylene diene (EPDM), styrene butadiene rubber (SBR), neoprene, and natural rubber (60). In addition, natural rubber (40), currently used on the 120-mm PA154 metal container, was used as a baseline. The 60 and the 40 are the durometer reading. A down select process would be used to determine the best gasket candidate by good performance in environment and material testing.

Based on successful testing, an engineering change proposal (ECP) will be submitted to implement the best gasket material in both the 120-mm and 81-mm metal containers.

OBJECTIVE

Analyze and study the properties of different gasket materials and conduct testing in-house or at the metal container producer facility to determine the best gasket material for the metal container for mortar ammunition.

Five gasket materials tested	
Neoprene gasket	20
Styrene butadiene (SBR)	20
Natural rubber – durometer (60)	20
Natural rubber – durometer (40)	20
Ethylene propylene diene (EPDM)	20

Items used in the testing	Quantity
PA 154, 120-mm mortar metal ammunition containers	60
PA153 fiber container with inert weight	12

Equipment

- Temperature conditioning chamber
- Loose cargo vibration machine
- Drop test equipment
- 3 psi pressure differential vacuum chamber

Test preparations

- Limited tests were performed in accordance with the MIL-STD-1904A.
- There were five different gasket materials tested at two different temperatures: -65°F and +160°F.
- Each group consisted of 12 containers. Six containers for hot and six containers for cold.
- Each test container was temperature conditioned for 24 hrs prior to testing.
- Leak tests were performed before and after each test.
- Test plan.

Test Result Explanation

- Pass indicates that the container maintained the 3-psi seal.
- Fail indicates that the container does not maintained the 3-psi seal.

METHODOLOGY

The WECAC Materials Laboratory suggested four potential materials to replace the current gasket. These four materials were EPDM, SBR, neoprene, and natural rubber (60). In addition, natural rubber (40) is currently used in the 120-mm PA154 metal container and was used as a baseline. The difference in the two natural rubbers is the hardness. The current natural rubber has a hardness of 40 and the potential replacement natural rubber has a higher hardness of 60. The SBR is currently used in the 81-mm metal ammunition container (PA156/PA157).

All five materials, including the natural rubber (40) (tested as product baseline), were tested at cold (-65°F) and hot (+160 °F) in environmental and material testing. The metal containers tested were used containers from Ft. Benning. The old gaskets in the PA154 metal containers were removed and the new gaskets were installed. The metal containers were loaded with two-fiber tubes filled with sand to simulate the actual pack-out weight. Twelve containers were tested for each gasket material. Out of these 12 containers, six containers were used in the cold (-65°F) and another six containers in hot (+160 °F) testing. The containers were marked for hot (1H, 2H, 3H, 4H, 5H, 6H) and for cold (1C, 2C, 3C, 4C, 5C, 6C).

The environmental testing included: 3 psi pressure retention test, 16-ft stacking test, 3-ft drop test, 7-ft drop test, and loose cargo vibration test. A secure cargo test was performed only on the best material selected from passing the environment and material tests.

The four materials and baseline were subjected to a series of property and performance tests in accordance with ASTM standard. The material testing included:

- Compression set (ASTM-D-395)
- Tension properties (ASTM-D-412)
- Resistance to liquid (ASTM-D-471)
- Tear resistance (ASTM-D-518)

- Durometer hardness (ASTM-D-2240)
- Low temperature (ASTM-D-3847)
- Resistance to dry heat (ASTM-D-3854)
- Testing temperatures (ATM-D-1349)

For further details, see ARDEC Technical Report ARWEC-TR-01008.

ENVIRONMENT TESTING

After completion of the material property testing, it was found that the SBR performed poorly after exposure to petrochemical. The natural rubber (60) showed poor results after exposure to petrochemical, heat, and heat/humidity. The materials testing laboratory recommended that the SBR and Natural Rubber (60) be eliminated from the environment testing due to poor material properties. Therefore, only Natural Rubber (40), EPDM, and Neoprene were used for the further environmental testing.

Pressure Retention Test

The containers were temperature conditioned (-65 °F and +160 °F) for 24 hrs. The containers were then placed in the 3-psi vacuum. All containers passed the initial leak test. The test results follow.

Container	Material	Results
IH, 2H , 3H, 4H, 5H, 6H	Natural Rubber (40)	Pass
1C, 2C, 3C, 4C, 5C, 6C	Natural Rubber (40)	Pass
1H, 2H, 3H, 4H, 5H, 6H	EPDM	Pass
1C, 2C, 3C, 4C, 5C, 6C	EPDM	Pass
1H, 2H, 3H, 4H, 5H, 6H	Neoprene	Pass
1C, 2C, 3C, 4C, 5C, 6C	Neoprene	Pass

Stacking Test

The three PA153 containers were loaded with two fiber tubes filled with sand and placed under the 1,200 lb weight for 24 hrs (fig. 1). The 1,200 lb weight is the approximate stacking height of 16 ft used in the storage facility. The loaded containers were maintained for a minimum of 24 hrs. This test was conducted at ambient temperature.

The containers were tested and were found to have no visible damage. After 24 hrs of stacking, the containers were check for leaks. All the containers maintained the 3-psi seal and did not leak. The results follow.

Container	Material	Results
IH, 2H , 3H, 4H, 5H, 6H	Natural Rubber (40)	Pass
1C, 2C, 3C, 4C, 5C, 6C	Natural Rubber (40)	Pass
1H, 2H, 3H, 4H, 5H, 6H	EPDM	Pass
1C, 2C, 3C, 4C, 5C, 6C	EPDM	Pass
1H, 2H, 3H, 4H, 5H, 6H	Neoprene	Pass
1C, 2C, 3C, 4C, 5C, 6C	Neoprene	Pass

Figure 1
Stacking test

Three-foot Drop Test

This test simulated accidental free fall drops of packaged ammunition during storage, maintenance, or issue operations. The tests were conducted on packages of depalletized ammunition weighing 150 lb or less. All PA154 containers were subjected to the 3-ft drop at six orientations. The six orientations are top, topside, short flat side, long flat side, bottom and corner. Figure 2 shows the six orientations on the automated drop test machine. After the drop, the containers were allowed to cool down or heat up before performing the leak test. Neoprene performed the best. The results follow.

Natural Rubber: Hot

Container	Material	Results
1H	Natural Rubber (40)	Fail (top left corner)
2H	Natural Rubber (40)	Pass
3H	Natural Rubber (40)	Fail (top right corner)
4H	Natural Rubber (40)	Fail (top left corner)
5H	Natural Rubber (40)	Fail (top left corner)
6H	Natural Rubber (40)	Fail (top left corner)

Natural Rubber: Cold

Container	Material	Results
1C	Natural Rubber (40)	Fail (top left corner)
2C	Natural Rubber (40)	Fail (top left corner)
3C	Natural Rubber (40)	Pass
4C	Natural Rubber (40)	Fail (top right corner)
5C	Natural Rubber (40)	Pass
6C	Natural Rubber (40)	Fail (top right corner)

EPDM: Hot

Container	Material	Results
1H	EPDM	Fail (top short side)
2H	EPDM	Fail (top left corner)
3H	EPDM	Fail (top short side)
4H	EPDM	Fail (top short side)
5H	EPDM	Fail (top left corner)
6H	EPDM	Fail (top long side)

EPDM: Cold

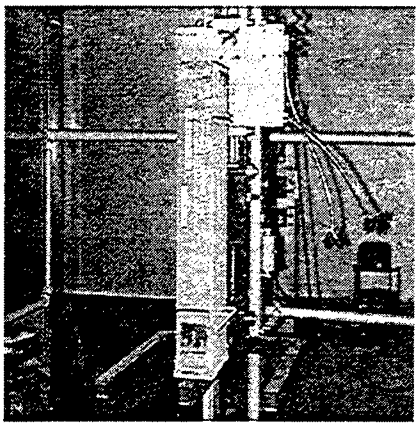
Container	Material	Results
1C	EPDM	Fail (top right corner)
2C	EPDM	Fail (top short side)
3C	EPDM	Fail (top long side)
4C	EPDM	Fail (top left corner)
5C	EPDM	Fail (top long side)
6C	EPDM	Fail (top short side)

Neoprene: Hot

Container	Material	Results
1H	Neoprene	Fail (Top left corner)
2H	Neoprene	Fail (Top right corner)
3H	Neoprene	Pass
4H	Neoprene	Pass
5H	Neoprene	Pass
6H	Neoprene	Pass

Neoprene: Cold

Container	Material	Results
1C	Neoprene	Pass
2C	Neoprene	Pass
3C	Neoprene	Pass
4C	Neoprene	Fail (Top short side)
5C	Neoprene	Fail (Top left corner)
6C	Neoprene	Fail (Top left corner)



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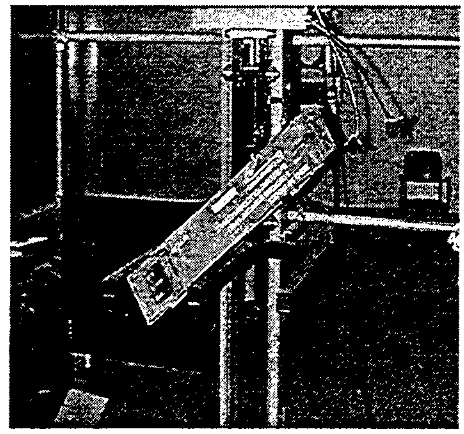
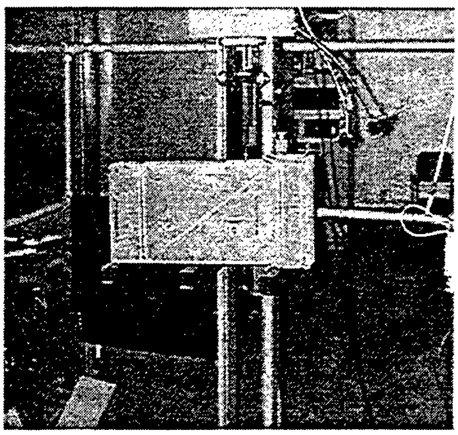
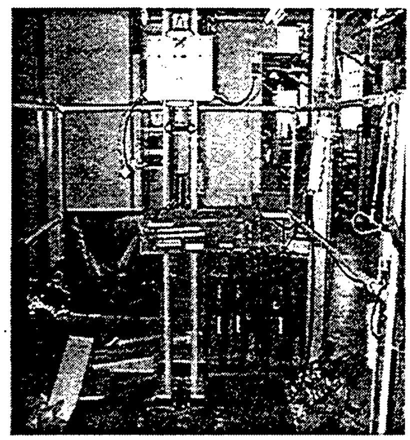


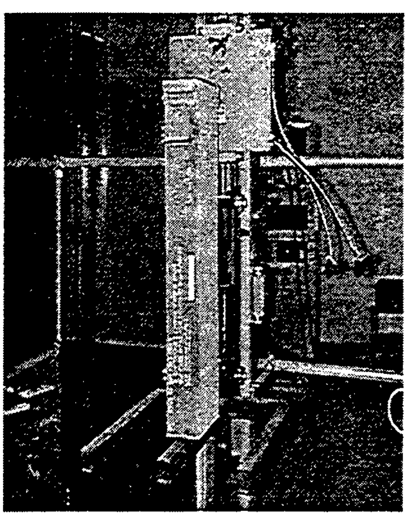
Top side



Short flat side



Long flat side



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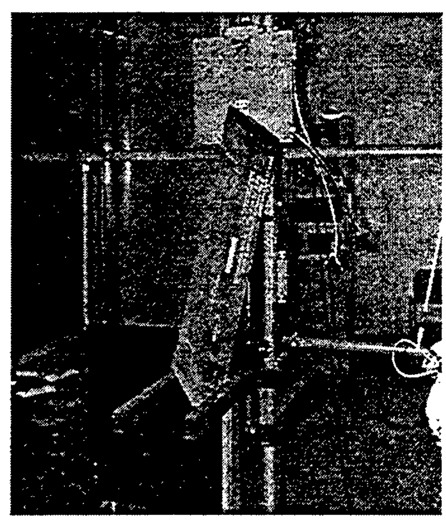


Cornor

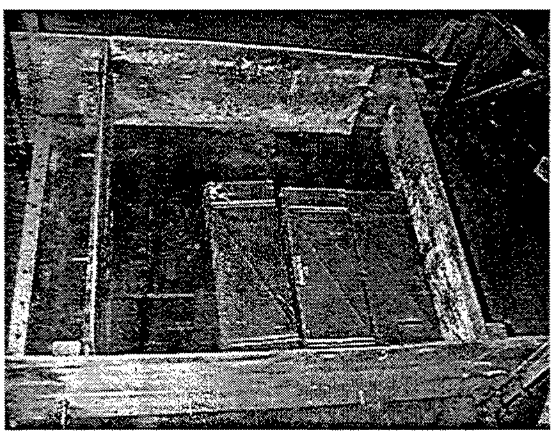
Figure 2
3-ft drop test

Loose Cargo Vibration Test

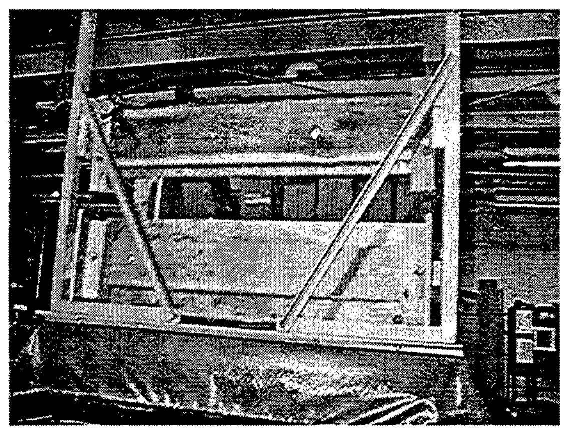
The containers were subjected to the loosely stored cargo test in accordance with MIL-STD-1904. All containers were tested at hot and cold temperature. The containers were conditioned at –65°F (cold) and 165°F (hot) for a minimum of 24 hrs prior to the loose cargo test. The loaded PA154s were placed on a steel-mounting table of the loose cargo machine and subjected to a frequency of 300 Hz. The containers were vibrated unconstrained for 15 min on both of their horizontal and vertical axis (fig. 3).

At the completion of testing, the containers went through the 3-psi pressure retention test. All the containers passed the test. The results follow.

Container	Material	Results
IH, 2H , 3H, 4H, 5H, 6H	Natural Rubber (40)	Pass
1C, 2C, 3C, 4C, 5C, 6C	Natural Rubber (40)	Pass
1H, 2H, 3H, 4H, 5H, 6H	EPDM	Pass
1C, 2C, 3C, 4C, 5C, 6C	EPDM	Pass
1H, 2H, 3H, 4H, 5H, 6H	Neoprene	Pass
1C, 2C, 3C, 4C, 5C, 6C	Neoprene	Pass



Horizontal loose cargo



Vertical loose car

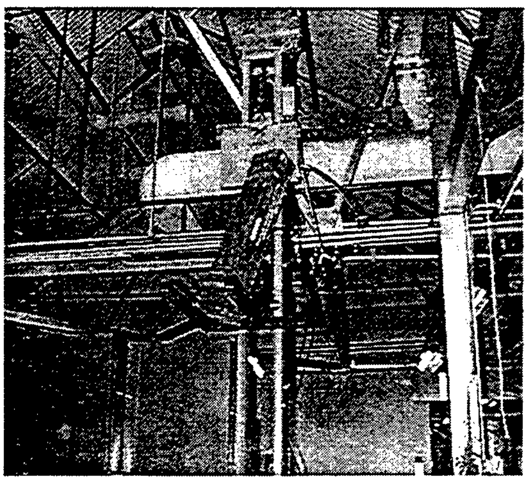
Figure 3
Loose cargo vibration test

Seven-foot Drop Test

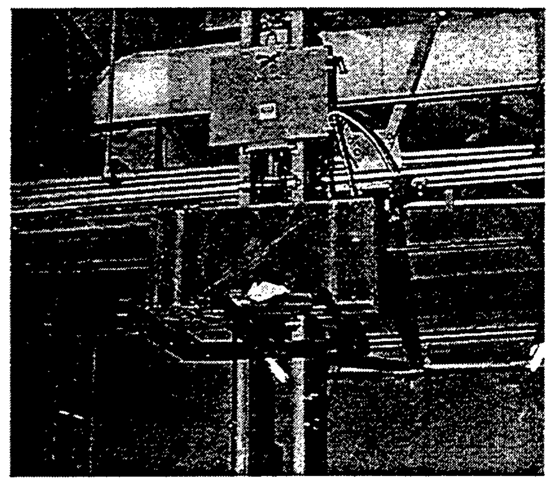
This test simulated free fall drops of packaged ammunition from a truck or a hovering helicopter dropping packaged ammunition from a sling and is normally conducted on packages of depalletized ammunition weighing 150 lbs or less. The loaded PA154 containers were subjected to 7-ft drops at one orientation per container. Figure 4 will show the orientation on the drop machine prior to the 7-ft drops.

The containers results follow. The requirement for the test was to make sure the rounds inside were not damaged. The rounds used were inert rounds. The pass criteria are the engineering determination based on the condition of the exterior and interior containers. The containers can be damaged and leak, although the containers must retain their contents and be able to be handled. The test results follow.

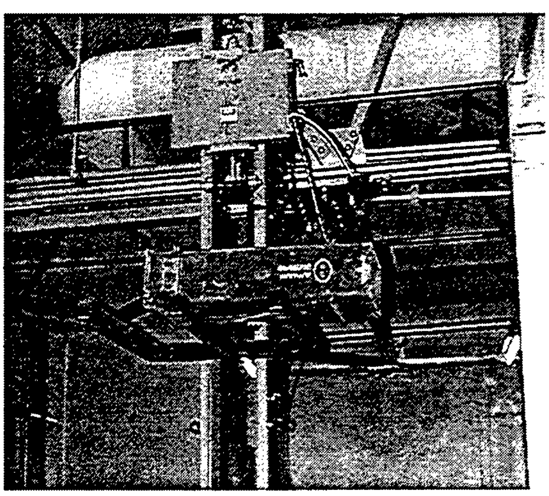
Container	Material	Gasket	Results
IH, 2H , 3H, 4H, 5H, 6H	Natural Rubber (40)	Pass	Leak (Top short side)
1C, 2C, 3C, 4C, 5C, 6C	Natural Rubber (40)	Pass	Leak (Top long side)
1H, 2H, 3H, 4H, 5H, 6H	EPDM	Pass	Leak (Top left corner)
1C, 2C, 3C, 4C, 5C, 6C	EPDM	Pass	Leak (bottom left corner)
1H, 2H, 3H, 4H, 5H, 6H	Neoprene	Pass	Leak (bottom reinforcement bar)
1C, 2C, 3C, 4C, 5C, 6C	Neoprene	Pass	Leak (reinforcement welding joint)



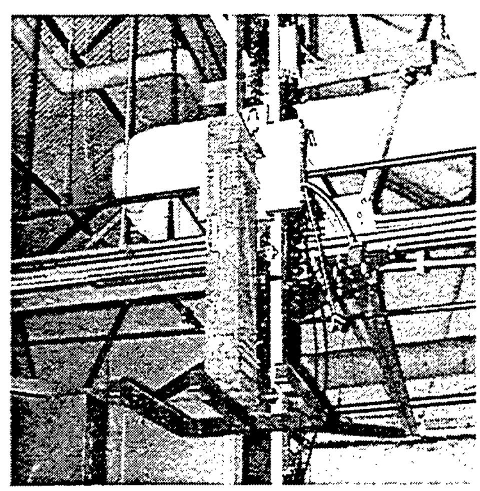
Top corner drop



Long flat drop

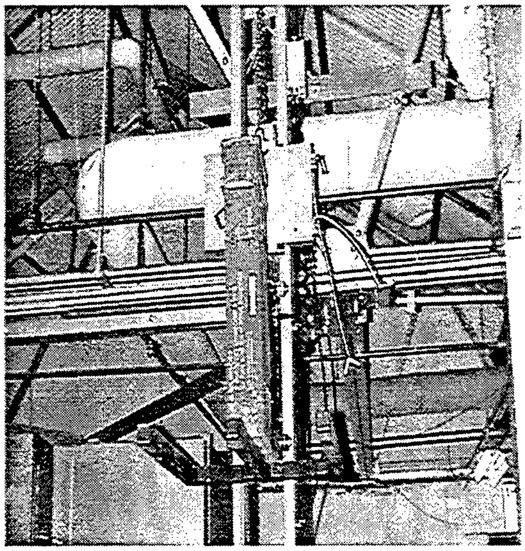


Flat long drop

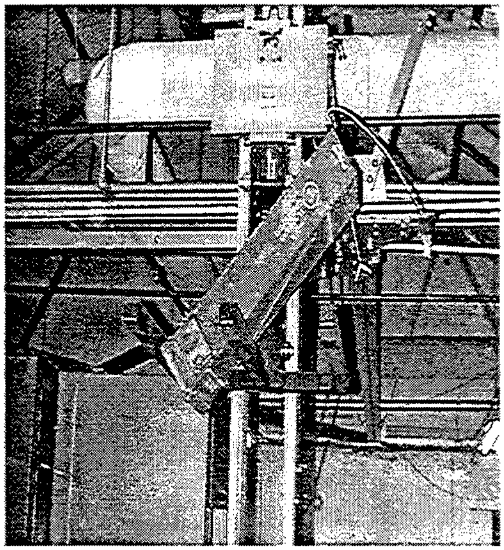


Bottom drop

Figure 4
7-foot drop test



Top drop



Top side drop

Figure 4
(continued)

Secured Cargo Test

This test was conducted only on the Neoprene gasket, which performed the best of all candidate material in both environmental and material tests. Six containers were used for this test. The six containers were tested at hot (+160°F) and cold (-65°F).

The containers were subjected to the secured-cargo vibration simulation in each of their three major orthogonal axes (vertical, transverse, and longitudinal). Testing consisted of multiple loads of containers for each axis of vibration.

The first vibration environment represented off road conditions on the cargo bed of a composite of tactical wheeled vehicles. This composite wheeled vehicle vibration environment was conducted for 40 min in each of the three orthogonal axes, simulating 800 km (500 mi) of secured-cargo transport per axis (fig. 5).

Three Axes: Vertical, Transversal, and Longitudinal

Wheeled Vehicle – 40min

- N1 – Fail, visible damage to the container rib, stacking feature. Leak from rib, stacking feature. No damage to the gasket
- N2 – Fail, visible damage to the container rib, stacking feature. Weld leak at the rib, stacking feature. No damage to the gasket. Tiny leak at the top.
- N3 – Pass, no visible damage to the container. No damage to the gasket

- N4 – Pass, no visible damage to the container. No damage to the gasket.
- N5 – Pass, no visible damage to the container. No damage to the gasket.
- N6 – Fail, visible damage to the container rib, stacking feature. Leak from the rib, stacking feature.

Figure 5
Secure cargo test (composite wheeled vehicle)

The second vibration environment represented the off-road conditions on the cargo bed of the ¼-ton M416 and the 1½-ton M105A2 two wheeled trailers (fig. 6). These particular schedules were developed on a real time basis. The composite two-wheeled trailer vibration environment was conducted for 32 min in each of three orthogonal axes, simulating 52 km (32 mi) of secured-cargo transport per axis.

Both vibration environments were run sequentially for each axis of vibration. At the completion of all vibration tests, leak tests were performed. At the completion of the leak tests, the containers were opened and visually inspected. The results follow.

Three Axes: Vertical, Transversal, and Longitudinal

2 Wheeled Vehicle – 32 min

- N1 – Fail, visible damage to the container rib, stacking feature. Leak from the rib, stacking feature. No damage to the gasket
- N2 – Fail, visible damage to the container rib, stacking feature. Weld leak at the rib, stacking feature. No damage to the gasket. Tiny leak at the top.
- N3 – Pass, no visible damage to the container. No damage to the gasket
- N4 – Pass, no visible damage to the container. No damage to the gasket.

- N5 – Pass, no visible damage to the container. No damage to the gasket.
- N6 – Fail, visible damage to the container rib, stacking feature. Leak from the rib, stacking feature.

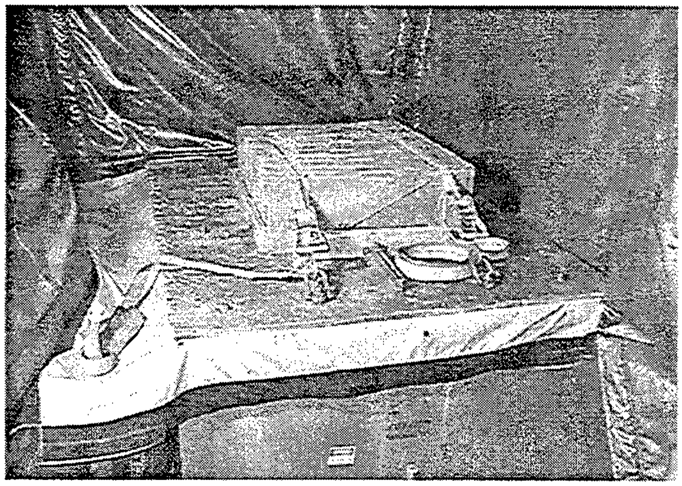


Figure 6
Secure cargo test (1/4-ton and 11/2-ton M105A2 two wheeled trailers

MATERIAL TESTING

The WECAC Armament Materials Team performed the material tests on elastomeric materials for a gasket replacement on 120-mm mortar metal containers (PA154). The neoprene gasket showed the best results in all the testing (app. B). For further details see ARDEC Technical report ARWEC-TR-01008.

CONTRACTOR TESTING

The current contractor (B-Way Corporation) performed the tests in October 2001 and agrees that the neoprene gasket performs as well or even better than the current natural rubber. Attached is the letter recommending the usage of neoprene gasket and test report (app. C).

CONCLUSION

The environmental and material tests showed that neoprene is the best gasket material for mortar metal ammunition containers. Styrene butadiene rubber and natural rubber (60) were discontinued from the environmental testing because of their poor performance in material tests (heat, oil, and grease). The ethylene propylene diene material did not perform well in drop test and leak test.

The environmental and material testing results both pointed out that the neoprene material was the best material for the application. The current contractor (B-Way Corporation) performed the tests in Oct 2001 and agreed that the neoprene gasket performs as well or even better than the current natural rubber.

RECOMMENDATIONS

The Packaging and Engineering Support Division, Picatinny Arsenal, New Jersey recommends using neoprene across the board for 81-mm and 120-mm metal shipping containers. The testing on the 120-mm container indicative of performance be similar because the 81 mm have similar design, sealing method, packaging; just lighter. Engineering Change Proposals (ECPs) are being submitted to incorporate the improvements.

APPENDIX A

Product Improvement Proposal

Mortars Product Improvement Summary Sheet

Product Improvement:

Improve/optimize the rubber gasket materials used on the 81mm and 120mm metal containers.

Item(s) Affected:
120mm PA154 and 81mm PA156/157 metal ammunition containers

Brief Description of Effort & Payoff:
The contractor, Bway Corp., reports that the synthetic rubber gaskets used on the PA156/157 81mm metal ammunition containers sometimes get cut during the rough handling testing. The 3 psi seal capability of the containers is compromised due to the damage to the gasket. The contractor proposes to change to use natural rubber gasket instead of synthetic rubber.

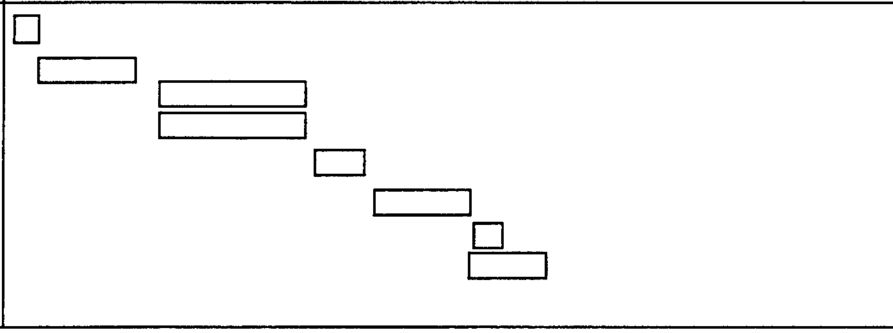
Natural rubber gaskets have been used on the heavier PA154 120mm metal ammunition container. Some preliminary testing conducted by the contractor showed that the natural rubber did not get cut when dropped. However, the physical properties of natural rubber normally deteriorate faster than synthetic rubber materials. Therefore, the natural rubber gasket (under closure pressure) is not an ideal candidate for long-term storage. This proposed PIP will address the durometer hardness, compress set, impact resistance and other physical properties of the gasket materials. A standardized/optimized gasket material will improve the seal capability of both 120mm and 81mm metal containers for long-term storage, shipping and transportation.

Possible Adverse Impacts:
None

Acquisition Strategy:
Analyze and study the properties of different gasket materials, conduct engineering testing in-house or at the metal container producer facility to determine the best gasket material for our application. A standardized material, if suitable, will be used for both the 81mm and 120mm containers. The selected materials will then be implemented into the container TDP.

Cost (In 99 Dollars):
Total: $80K
- Labor: Packaging, L. Freilich and Y. Sinha $35 K
- Materials Branch: T. Woo, $10K
- Test: B. 60/3109: POC: J. Grant $10K
- Contract with Container/Gasket Producer: $10K
- Materials/Fabrication: $15K

Schedule:

Activity	Project Time, Months
	CY00 CY01 **6 7 8 9 10 11 12 1 2 3 4 5 6 7**
Receive Funding Study Gasket Materials Obtain Gasket Materials Obtain Metal Containers Prepare Samples for Test Conduct Engineering Tests ECP/Drawing Update Report	

POC: Lenny Freilich, X2181 and Yash Sinha, X2557

APPENDIX B

Secure Cargo Test Data and Graphs
(All the data meets the criteria and are in acceptable range.)

Test Level: 0.000 dB
Test Time: 000:40:00

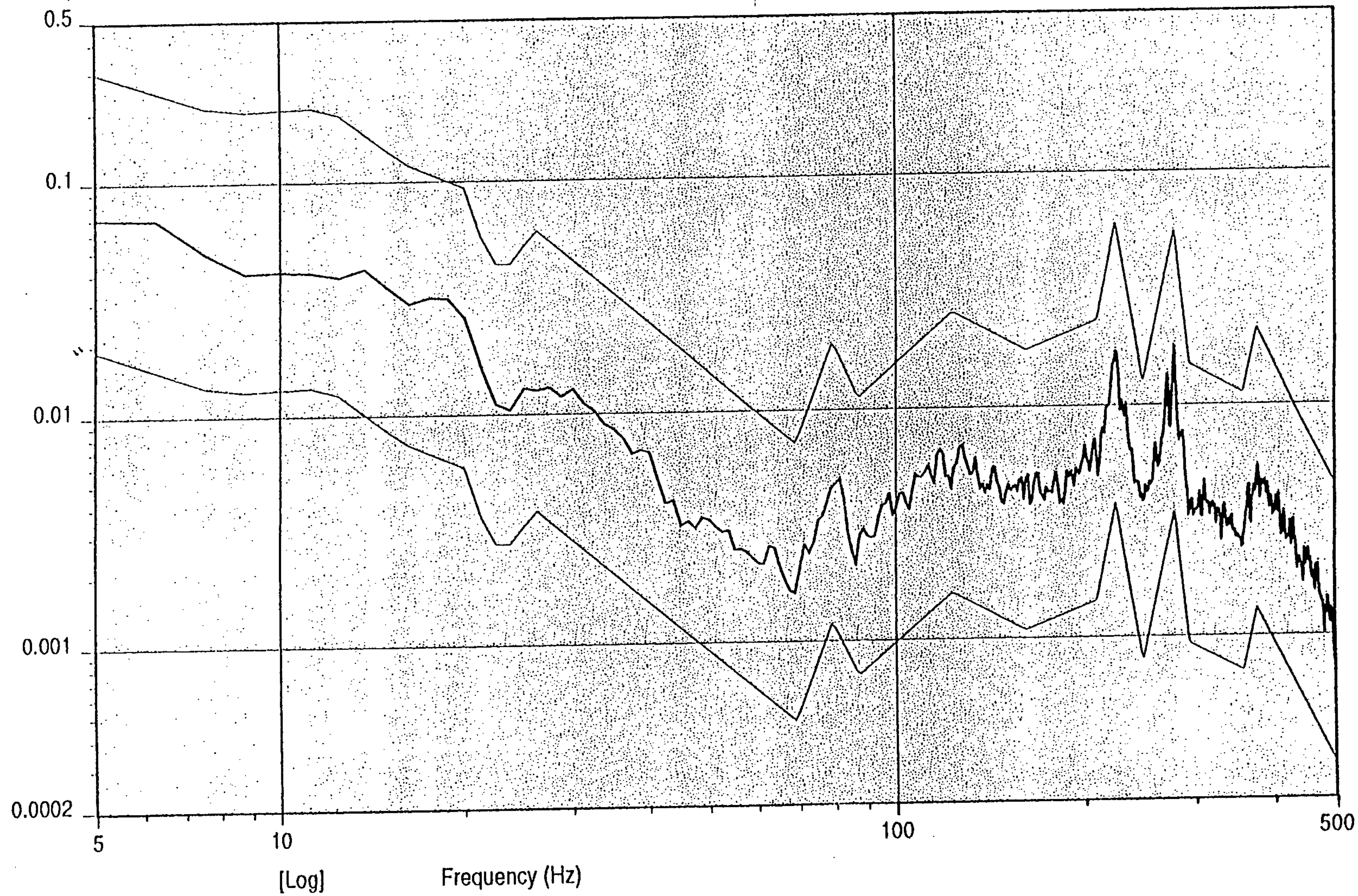
Reference RMS: 1.709
Clipping: 3.00 Sigma

Test Range: 5.000, 500.000 Hz
Resolution: 1.250 Hz

Control

[Log]

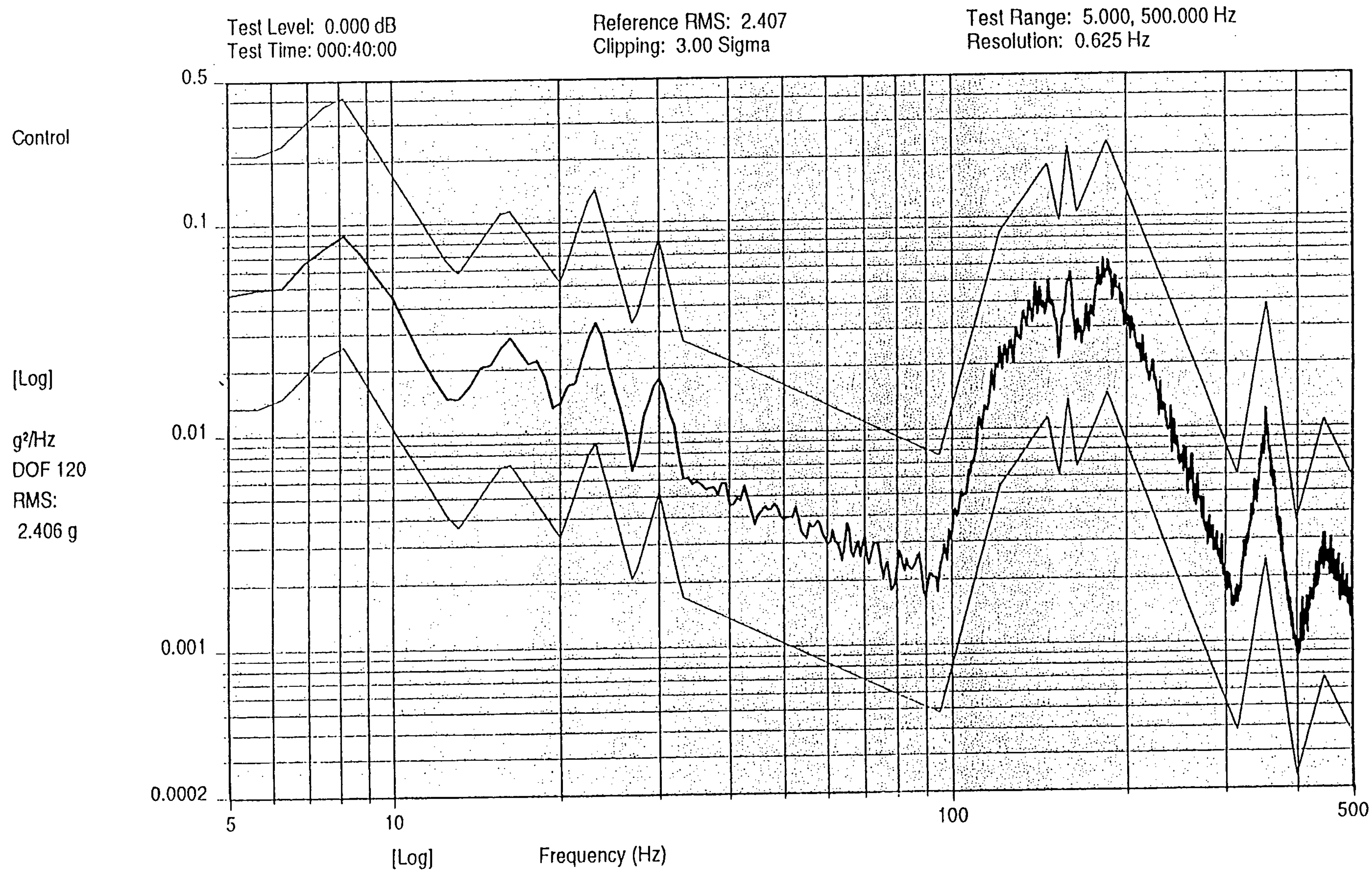
g²/Hz
DOF 120
RMS:
1.707 g



11:16:15
11-May-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181 (Mod. Curve)
MIL-STD-1904A (AR) Wheeled Vehicle Axis Vert. Temp. +160 F.

Test Name: 120MM-Cont.-Vert.-Vehicle.tmp



11:24:13
10-May-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181
MIL-STD-1904A (AR) Two Wheeled Trailer Axis Long. Temp. +160F.

Test Name: 120MM-Cont.-Long.-Trailer.tmp

Test Level: 0.000 dB
Test Time: 000:40:00

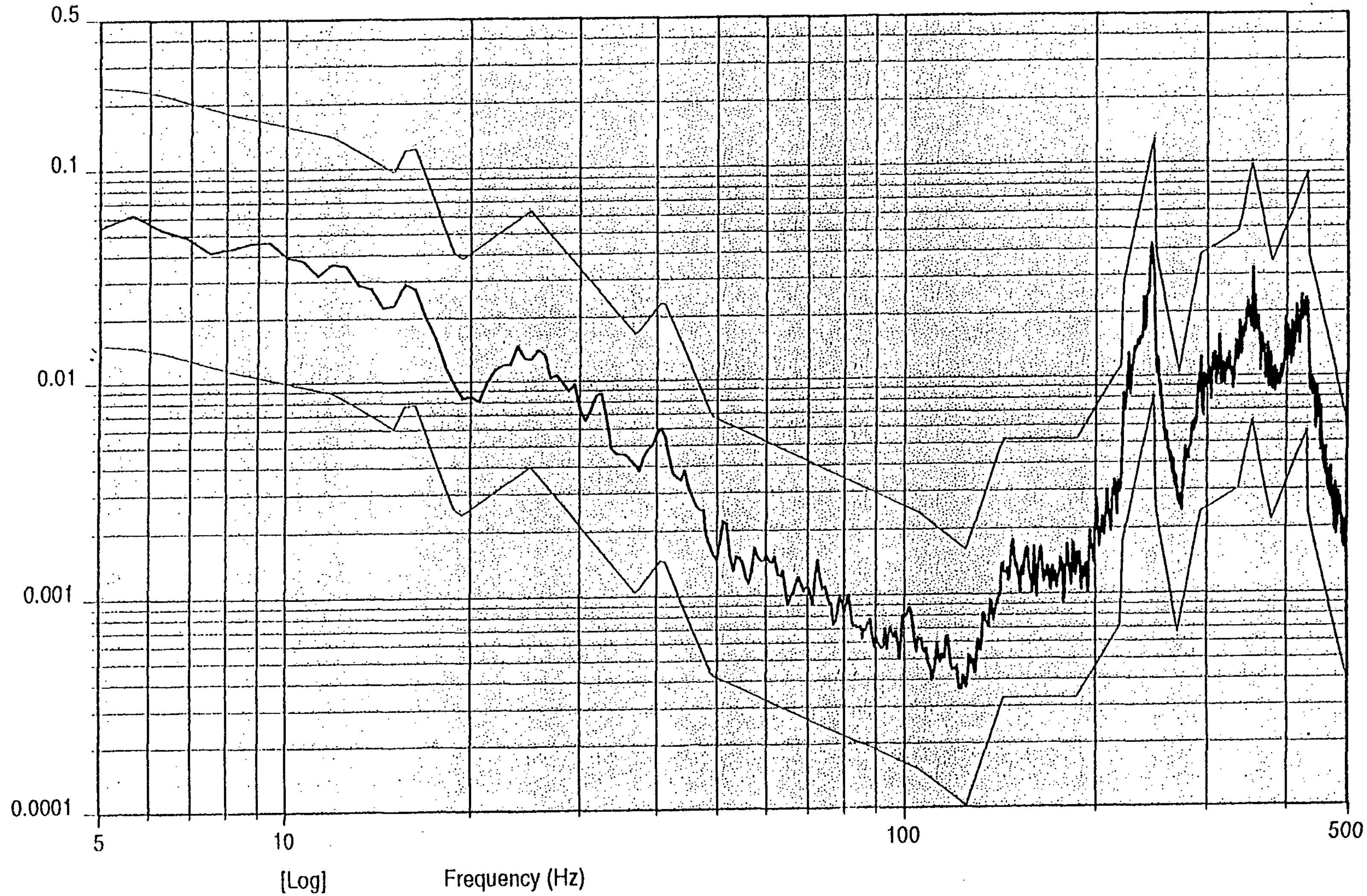
Reference RMS: 1.963
Clipping: 3.00 Sigma

Test Range: 5.000, 500.000 Hz
Resolution: 0.625 Hz

Control

[Log]

g²/Hz
DOF 120
RMS:
1.977 g



10:34:01
10-May-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181
MIL-STD-1904A (AR) Wheeled Vehicle Axis Long. Temp. +160 F.

Test Name: 120MM-Cont.-Long.-Vehicle.tmp

Test Level: 0.000 dB
Test Time: 000:40:00

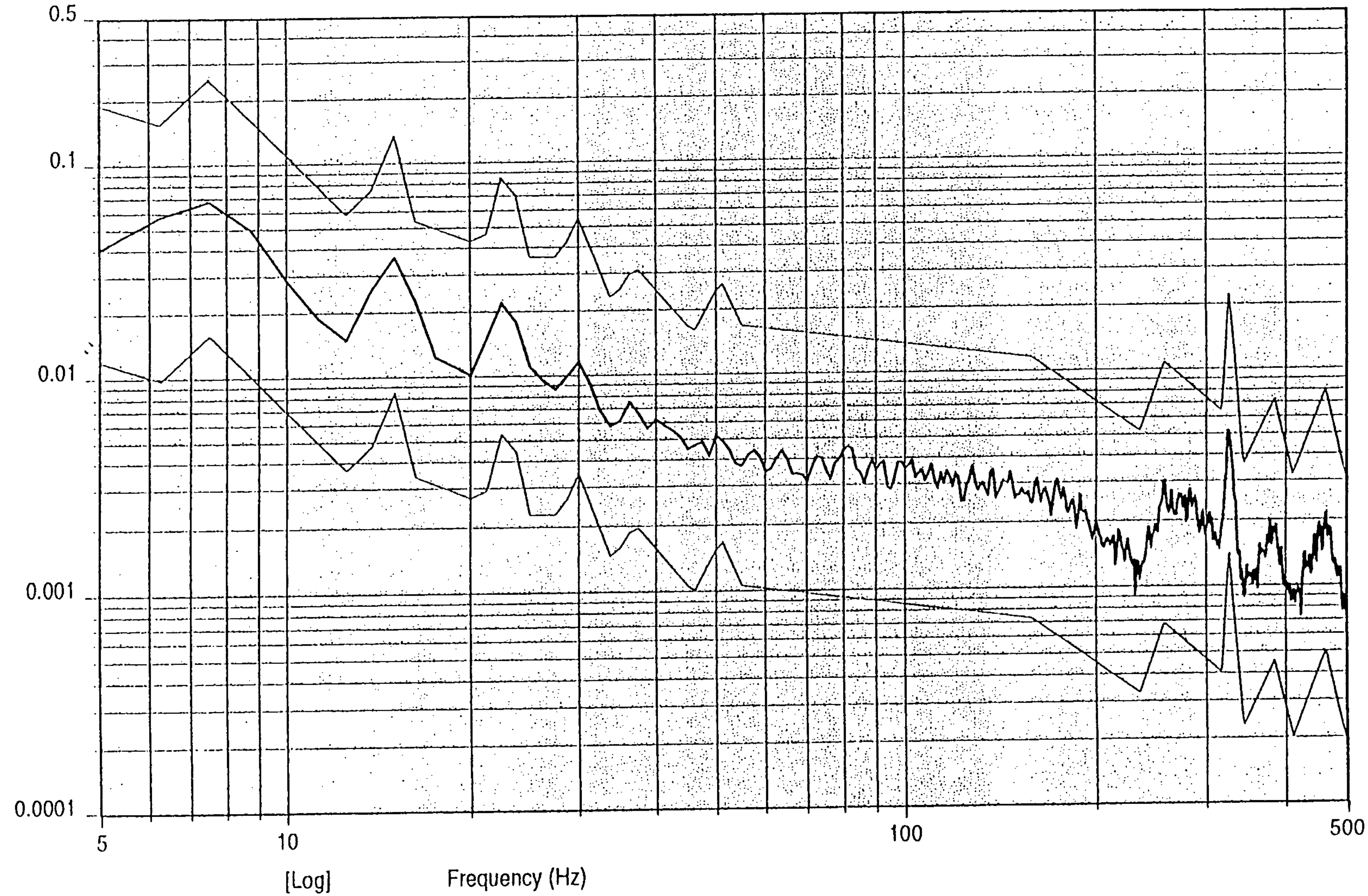
Reference RMS: 1.286
Clipping: 3.00 Sigma

Test Range: 5.000, 500.000 Hz
Resolution: 1.250 Hz

Control

[Log]

g²/Hz
DOF 120
RMS:
1.309 g



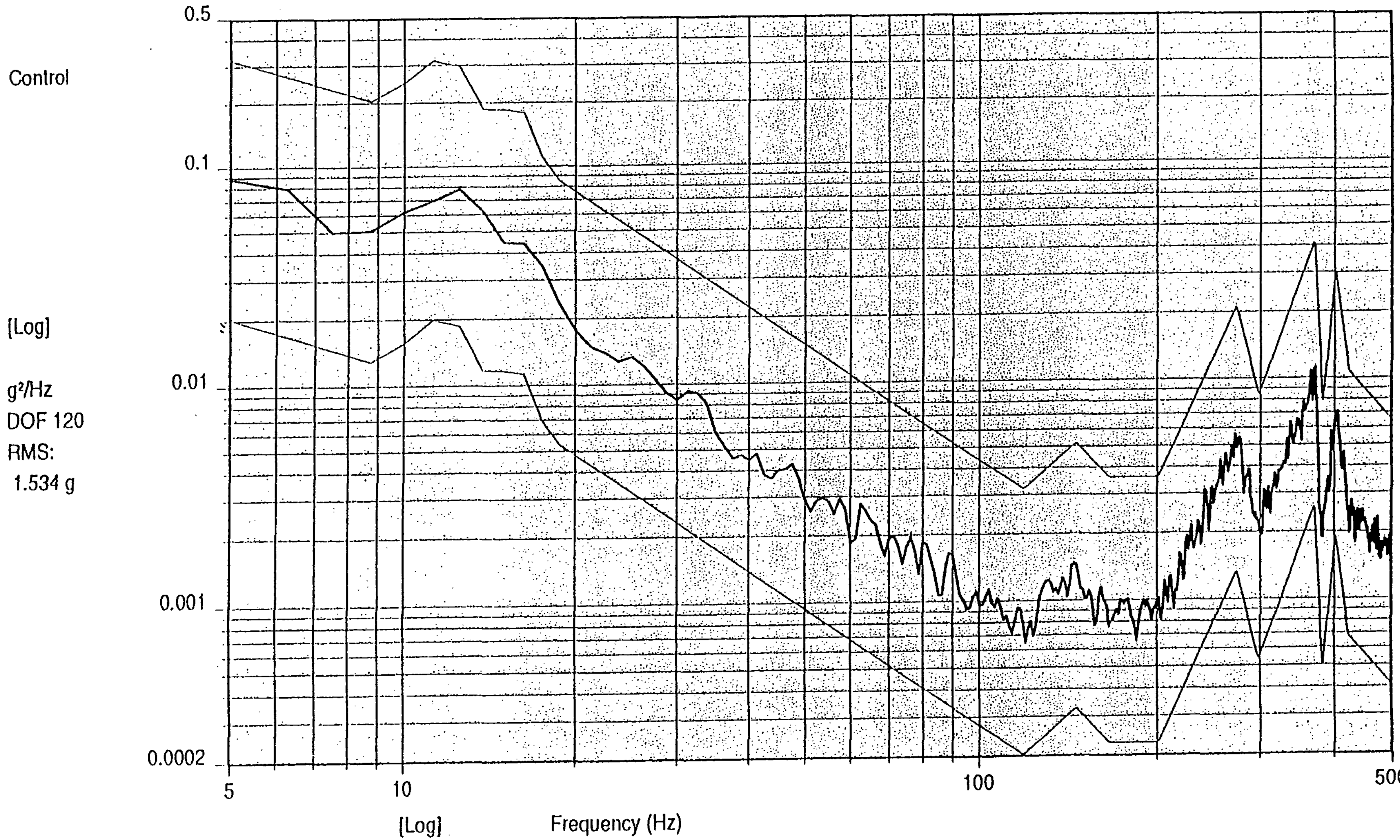
10:30:11
24-May-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181
MIL-STD-1904A (AR) Two Wheeled Trailer Axis Trans.Temp. +160 F.
Test Name: 120MM-Cont.-Trans.-~~Vehicle~~ TRAILER -Imp

Test Level: 0.000 dB
Test Time: 000:40:00

Reference RMS: 1.530
Clipping: 3.00 Sigma

Test Range: 5.000, 500.000 Hz
Resolution: 1.250 Hz



14:20:32
24-May-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181
MIL-STD-1904A (AR) [redacted] Wheeled Vehicle Axis Trans.Temp. +160 F.
Test Name: 120MM-Cont.-Trans.-Vehicle.tmp

Test Level: 0.000 dB
Test Time: 000:32:00

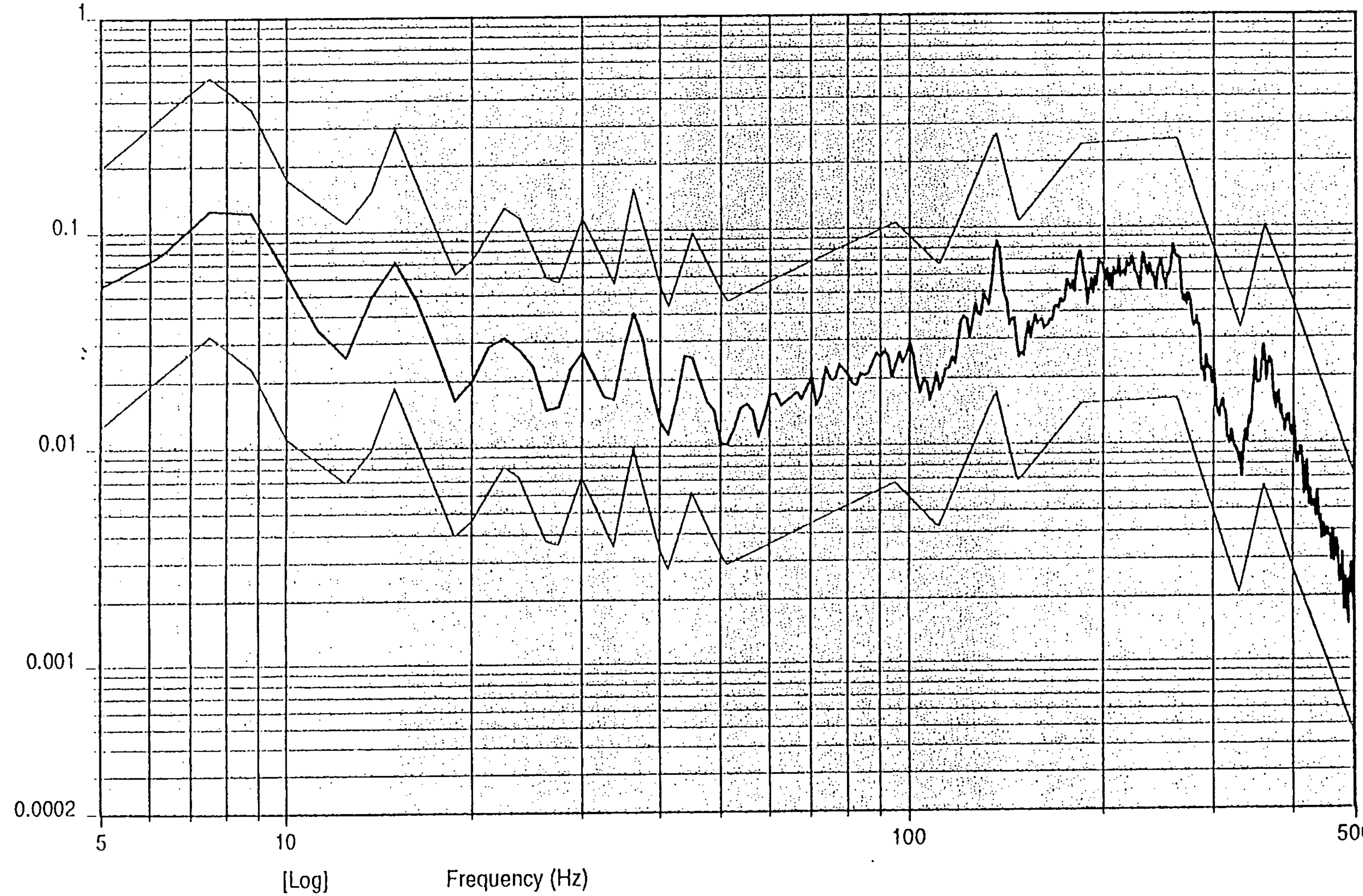
Reference RMS: 3.712
Clipping: 3.00 Sigma

Test Range: 5.000, 500.000 Hz
Resolution: 1.250 Hz

Auxiliary 1

[Log]

g²/Hz
DOF 120
RMS:
3.714 g

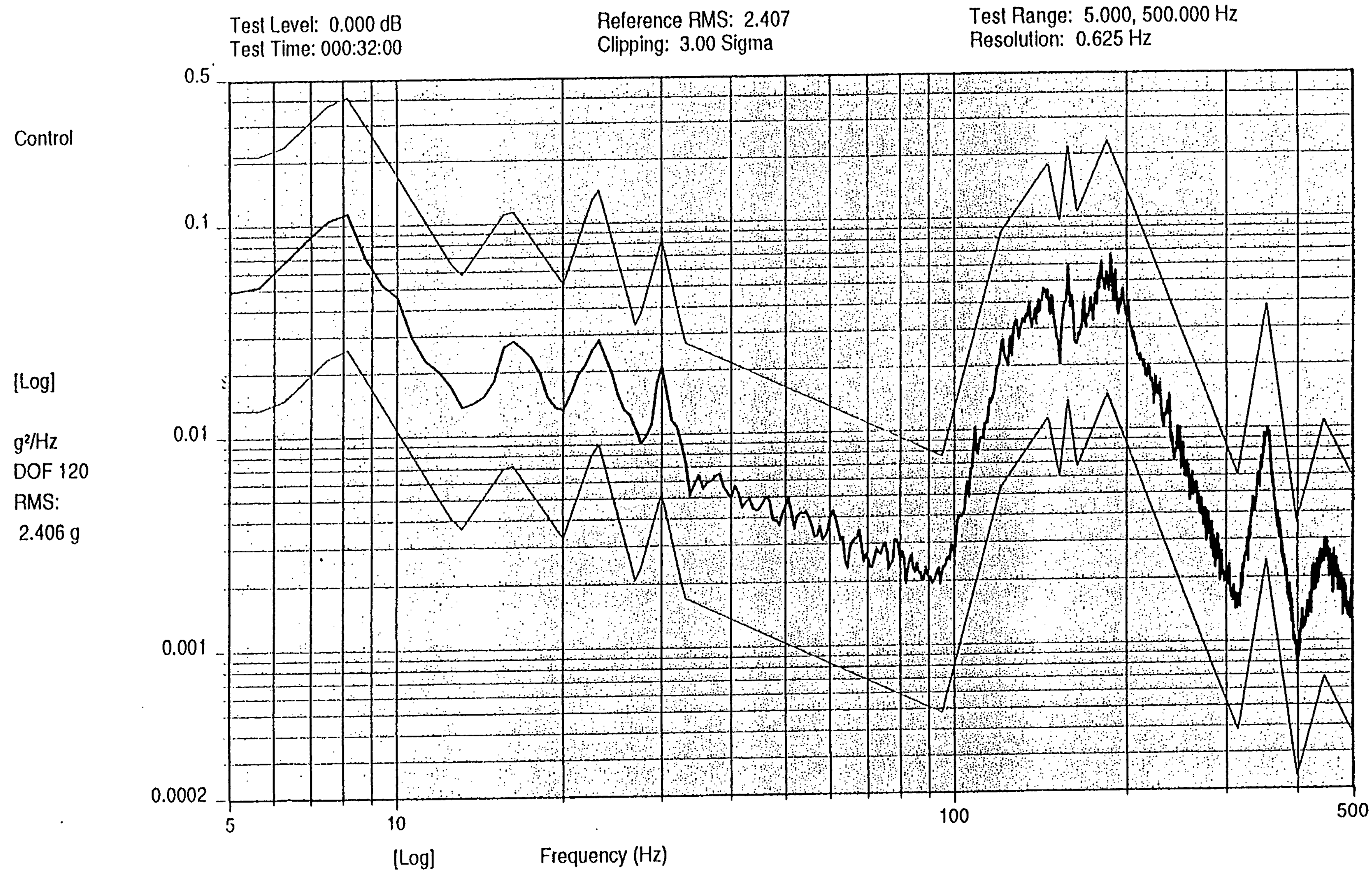


Channel 1 Label 1 Channel 1 Label 2

15:24:33
05-Jun-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181 (Mod. Curve)
MIL-STD-1904A (AR) Two Wheeled Trailer, Vert. Axis Temp. -65F.

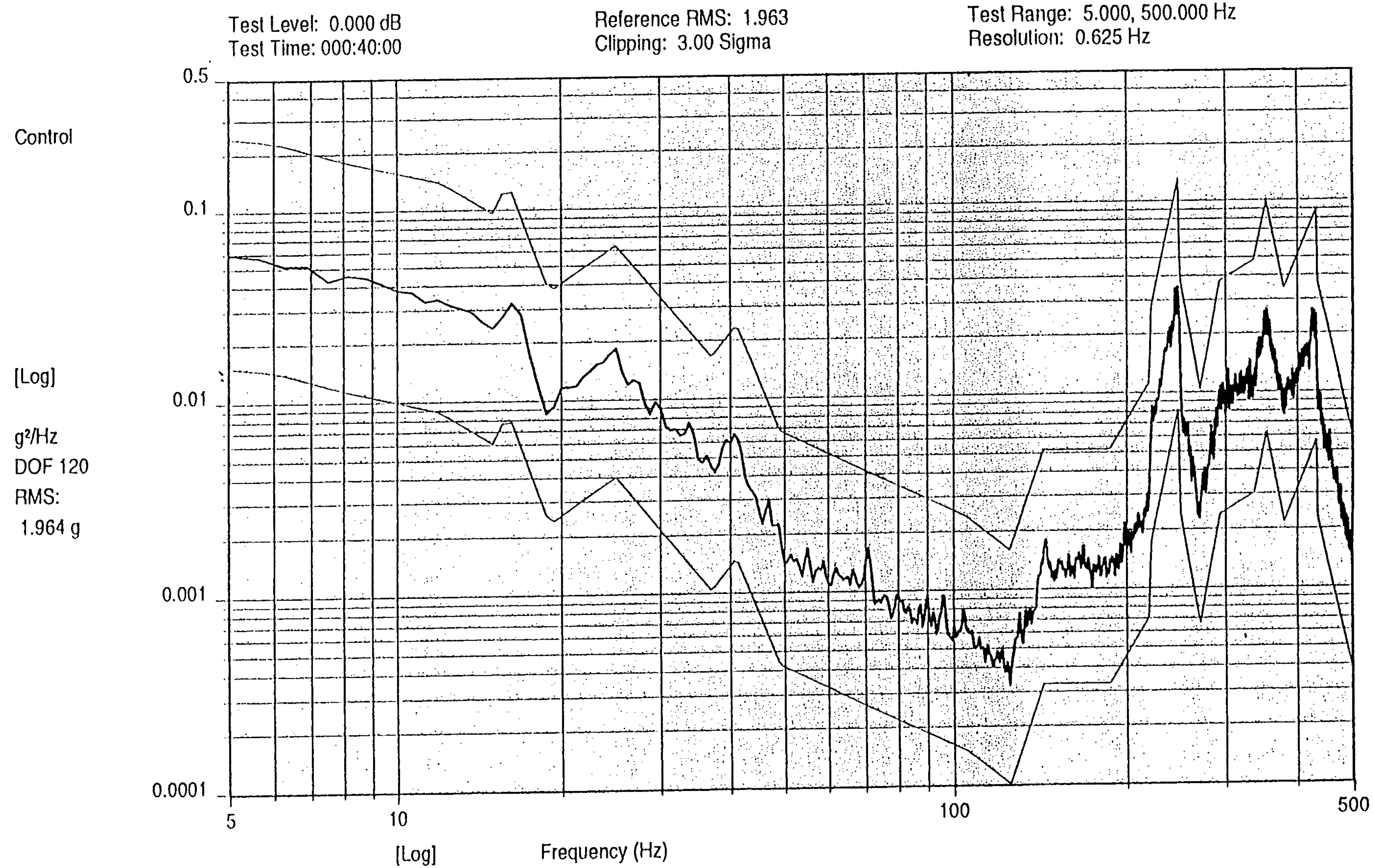
Test Name: 120MM-Vert.-Trailer-65f.001



10:51:56
06-Jun-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181
MIL-STD-1904A (AR) Two Wheeled Trailer Axis Long. Temp. -65F.

Test Name: 120MM-ContLongTrailer-65F.tmp



10:04:21
06-Jun-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181
MIL-STD-1904A (AR) Wheeled Vehicle Long. Axis Temp. -65 F.

Test Name: 120MM-Cont.Long-Vehicle-65F.tmp

Test Level: 0.000 dB
Test Time: 000:32:00

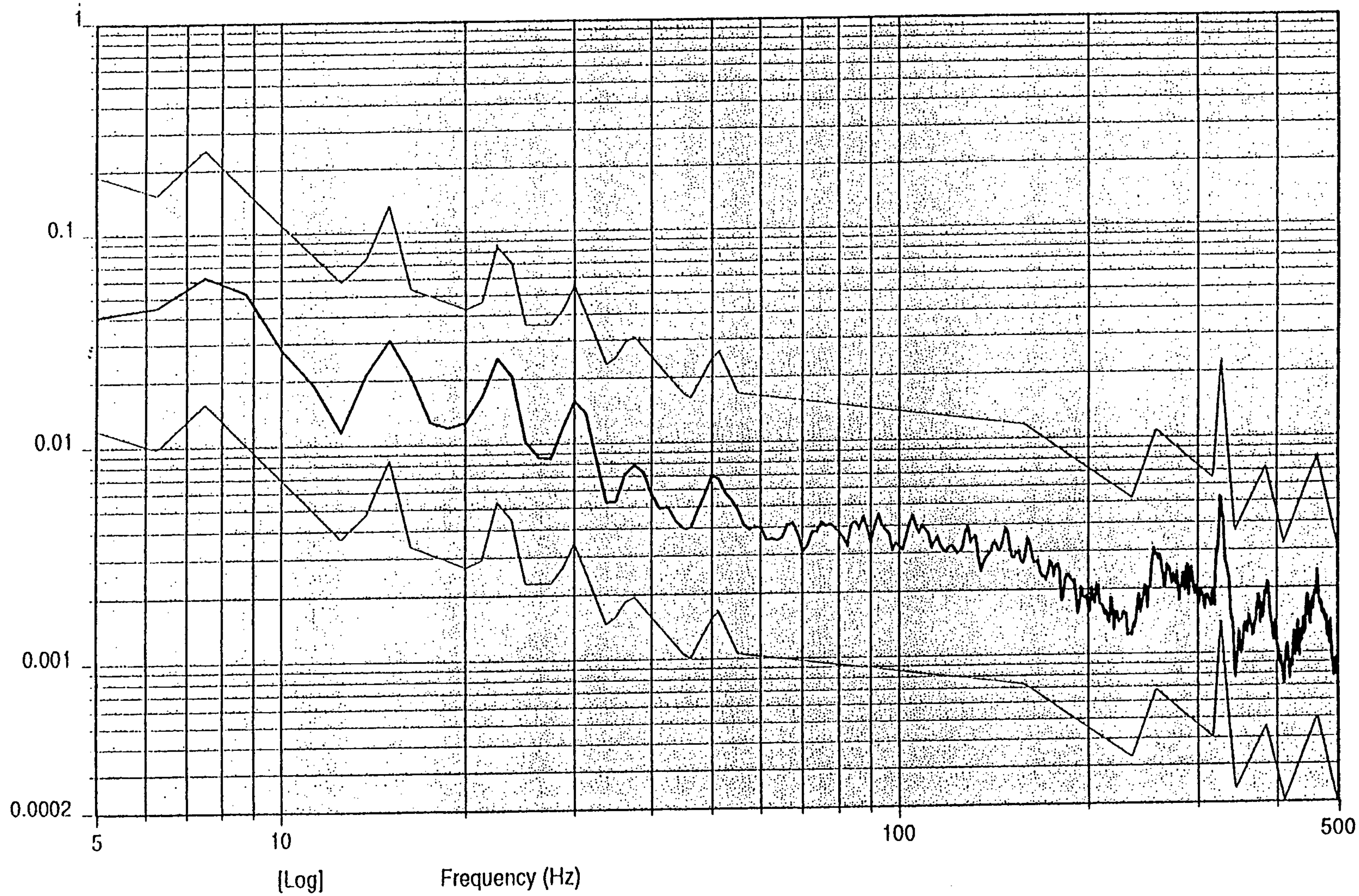
Reference RMS: 1.286
Clipping: 3.00 Sigma

Test Range: 5.000, 500.000 Hz
Resolution: 1.250 Hz

Control

[Log]

g²/Hz
DOF 120
RMS:
1.318 g



11:29:18
05-Jun-2001

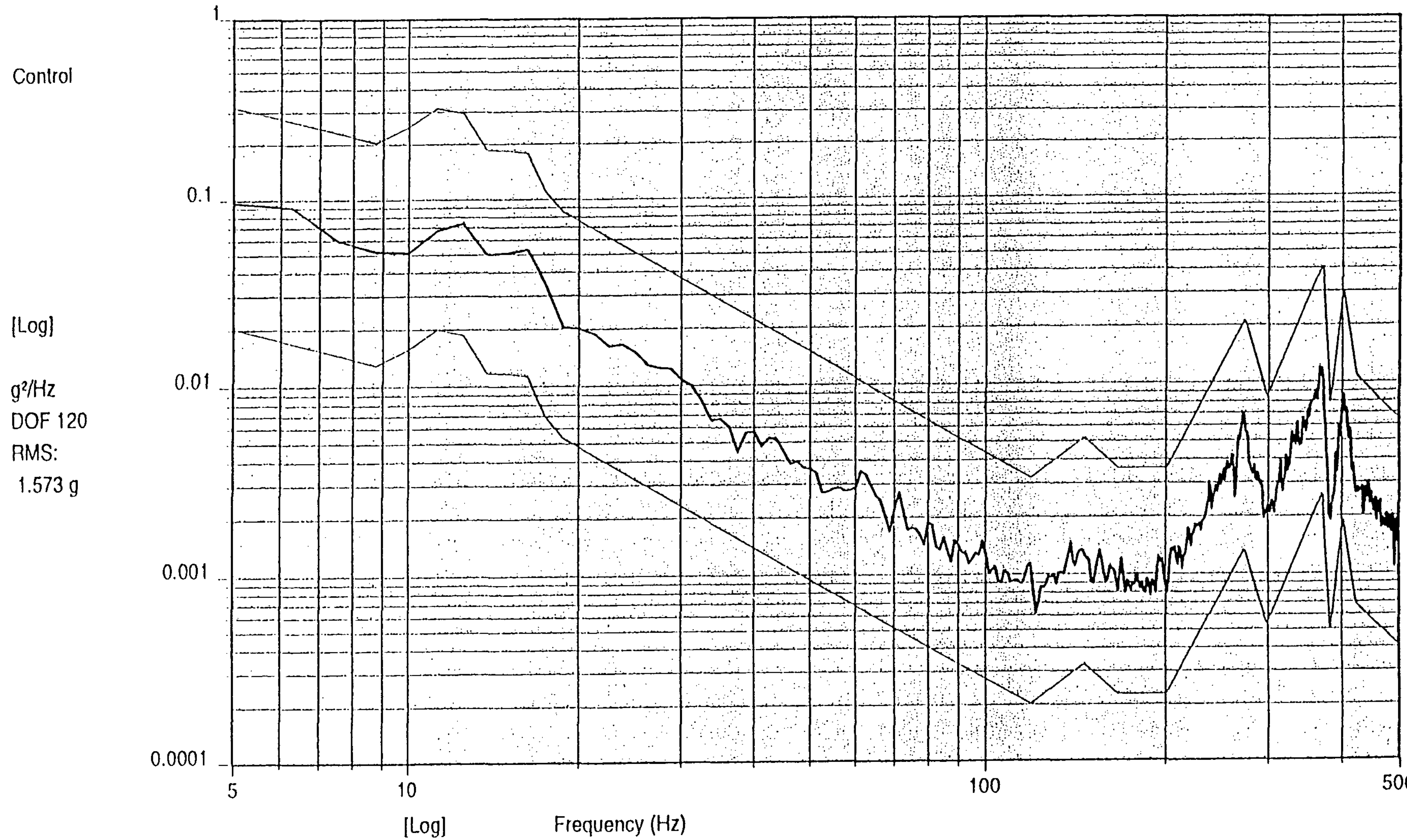
120MM Mortar Container POC: Sinha Tash Ext. 2181
MIL-STD-1904A (AR) Two Wheeled Trailer Trans.Axis Temp -65 F.

Test Name: 120MM-Cont.-Trans.-Trailer.003

Test Level: 0.000 dB
Test Time: 000:40:00

Reference RMS: 1.530
Clipping: 3.00 Sigma

Test Range: 5.000, 500.000 Hz
Resolution: 1.250 Hz



10:25:17
05-Jun-2001

120MM Mortar Container POC: Sinha Yash Ext. 2181
MIL-STD-1904A (AR) Wheeled Vehicle Trans. AXIS Temp. -65 F.

Test Name: 120MM-Trans.-Vehicle-65F.tmp

APPENDIX C

B-Way Corporation Test Report

GASKET TEST PLAN
B-WAY CORPORATION
OCT 3 – 5

Initial Leak Test

The new Neoprene gaskets are to be placed in the container lid. The testing will be done on six overpack containers, three conditioned to +160°F and three conditioned to -65°F for 24 hours.

The containers will be leak tested before placing in the temperature chambers.

Results:

Cold

#	Pass/Fail	Leak (y/N) Comments (inspected)
1	Pass	N
2	Pass	N
3	Pass	N

Hot

#	Pass/Fail	Leak (y/N) Comments (Inspected)
1	Pass	N
2	Pass	N
3	Pass	N

2) 3 feet Drop Testing

The testing will be done on six overpack containers, three containers conditioned to +160°F for 24 hours and three containers at -65°F. Each container will be dropped from the 3 ft height six times at six orientations onto a steel plate.

The six orientations will be: on the top, on the bottom, on the side, on the side (90º rotation from previous drop), 45º edge on the bottom and F) and 45º short edge on the bottom.

At the conclusion of the 3 ft drop test, all overpacks will be inspected and evidence of damage to the packing will be recorded.

Also, all overpacks will be leak tested after returning to the ambient temperature (recommend to be placed at the ambient for a minimum of 4 hours) and results recorded.

3-foot drop test result (+160ºF)

A) Test results at +160°F:

Each container will be dropped from the 3 ft height six times at six orientations onto a six-inch thick steel table. The six orientations are on the top, on the bottom, on the side, on the side (90º rotation from previous drop), 45º edge on the bottom and F) and 45º short edge on the bottom.

Hot Testing Results at +160°F:

Sample Number	Container Drop Orientations	Results
1	Top	Minor Denting
	Base down (bottom)	"
	Horizontal (Long Flat side)	"
	Short Side Horizontal	"
	Bottom 45° Corner	"
	Bottom short side	"
2	Top	"
	Base down (bottom)	"
	Horizontal (Long Flat side)	"
	Short Side Horizontal	"
	Bottom (lid) 45° Corner	"
	Bottom short side	"
3	Top	"
	Base down (bottom)	"
	Horizontal (Long Flat side)	"
	Short Side Horizontal	"
	Bottom (lid) 45° Corner	"
	Bottom short side	"

B) Test results at -65°F:

Cold Testing Results:

1	Top	Minor Denting
	Base down (bottom)	"
	Horizontal (Long Flat side)	"
	Short Side Horizontal	"
	Bottom (lid) 45° Corner	"
	Bottom short side	"
2	Top	"
	Base down (bottom)	"
	Horizontal (Long Flat side)	"
	Short Side Horizontal	"
	Bottom (lid) 45° Corner	"
	Bottom short side	"
3	Top	"
	Base down (bottom)	"
	Horizontal (Long Flat side)	"
	Short Side Horizontal	"
	Bottom (lid) 45° Corner	"
	Bottom short side	"

Final Leak Test Results:

After the drop, the containers will be 3 PSI leak tested and inspected.

Cold

#	Pass/Fail	Leak (y/N) Comments (inspected)
1	Pass	N
2	Pass	N
3	Pass	Bubbling below allowable level was visible; gasket inspection showed no cuts; possible trapped dirt or wrinkled gasket caused the bubbling.

Hot

#	Pass/Fail	Leak (y/N) Comments (Inspected)
1	Pass	N
2	Pass	N
3	Pass	N

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